First Order Low Pass Active Filter

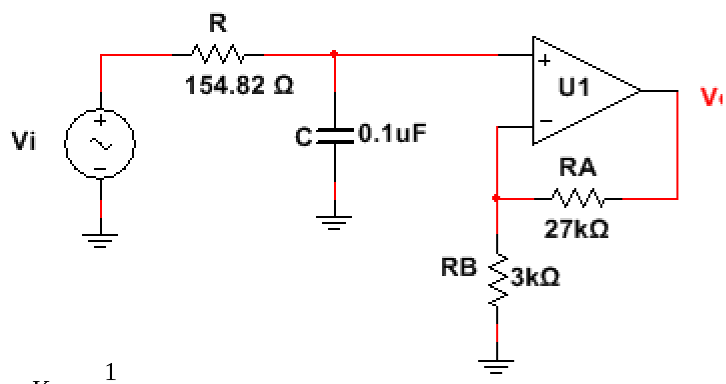
Specifications

$f_{crit} := 10.28\,kHz$ $\quad j := \sqrt{-1}$

Non Inverting DC Gain 20dB 3dB Frequency f_{crit}

$K := 10^{\frac{20}{20}} = 10$ Pick $C := 0.1\mu F$ Pick $R_B = 3k\Omega$ $R_A = 27k\Omega$

$T(s) = K \cdot \frac{1}{1 + s\tau}$ $\tau = RC$



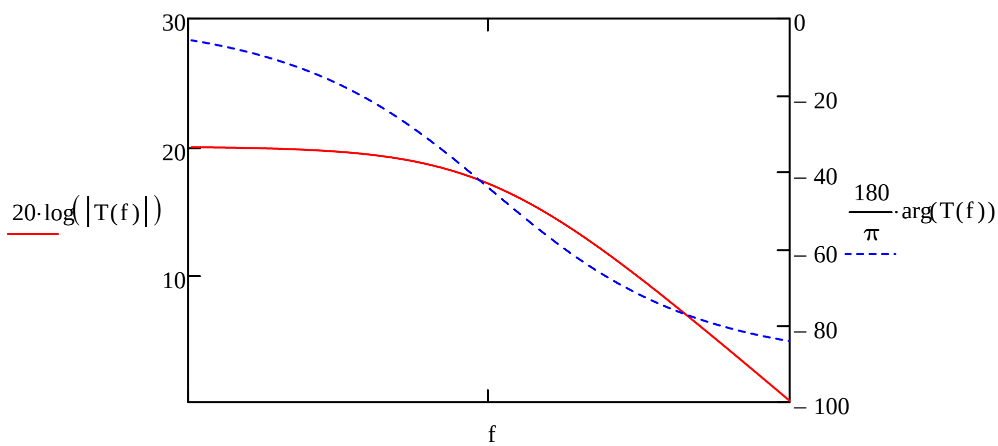
$K = T(0)$ $f_3 = \frac{1}{2\pi\tau}$

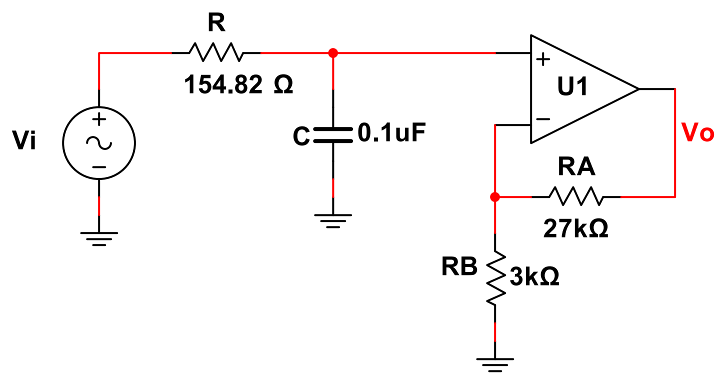
$f_3 := f_{crit}$

$R := \frac{1}{2 \cdot \pi \cdot f_3 \cdot C} = 154.82\Omega$

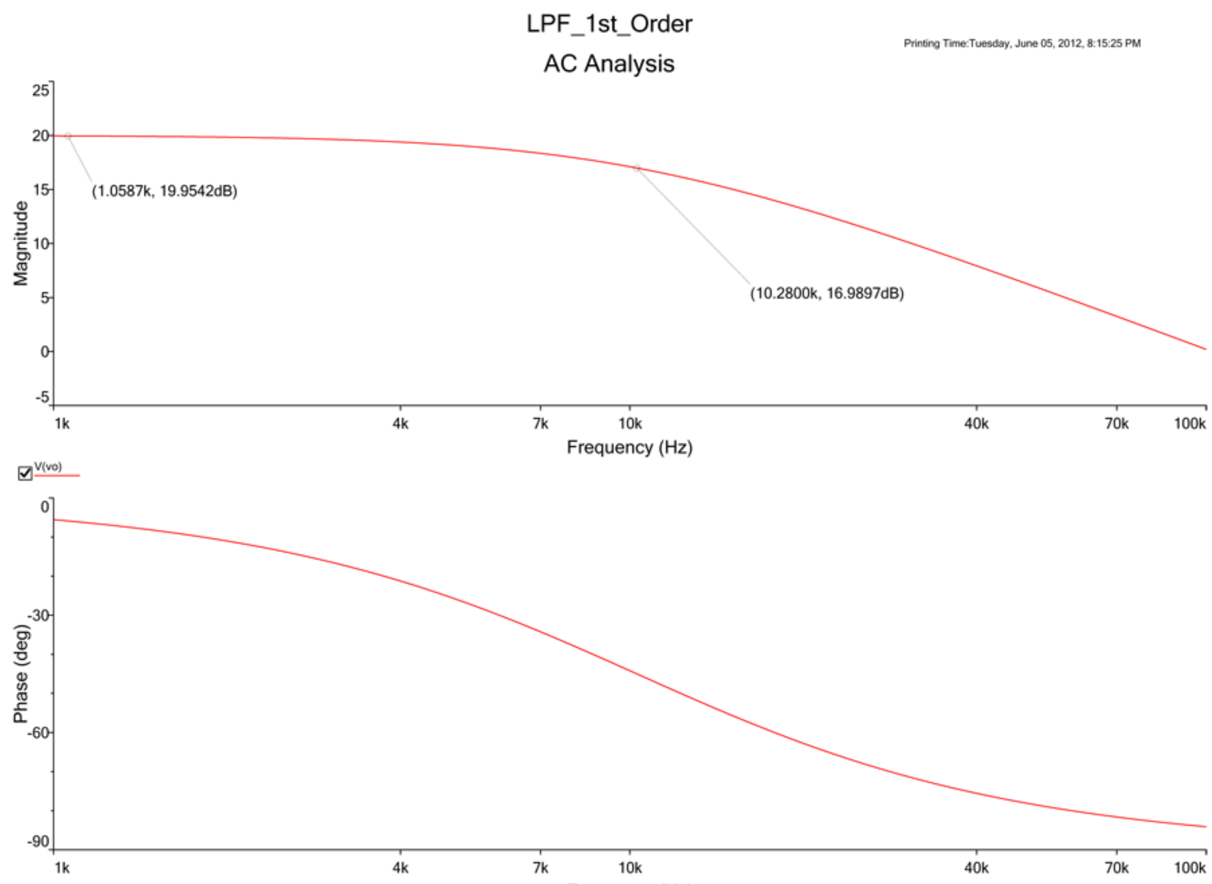
$K = 1 + \frac{R_A}{R_B}$

$T(f) := K \cdot \frac{1}{1 + j \cdot \frac{f}{f_3}}$

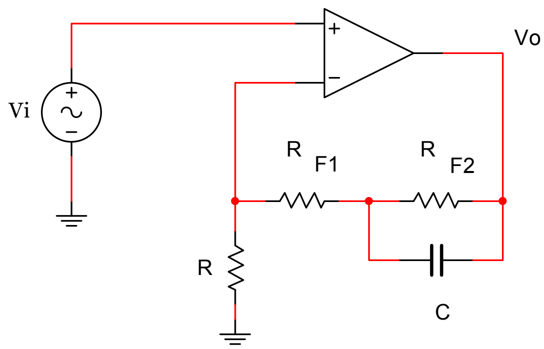



R
154.82 Ω
Vi
C
0.1uF
U1
Vo
RA
27kΩ
RB
3kΩ

First Orde


LPF_1st_Order
AC Analysis
Printing Time:Tuesday, June 05, 2012, 8:15:25 PM
Magnitude
(1.0587k, 19.9542dB)
(10.2800k, 16.9897dB)
Frequency (Hz)
V(vo)
Phase (deg)
Frequency (Hz)

Low Pass Shelfving Filter $j := \sqrt{-1}$ $f_{crit} := 10.28\,kHz$



$$T(s) = K\cdot\frac{1+s\tau_z}{1+s\tau_p}$$

$$T(0) = K = 1 + \frac{R_{F1}+R_{F2}}{R}$$

$$T(\infty) = 1 + \frac{R_{F1}}{R}$$

$$\tau_p = R_{F2}\cdot C$$

$$\tau_z = \left[R_{F2}\,\|\,\left(R_{F1}+R\right)\right]\cdot C$$

$$f_p = \frac{1}{2\pi\cdot\tau_p} \qquad f_z = \frac{1}{2\pi\,\tau_z}$$

Specification $f_p := f_{crit}$ DC gain 20dB

∞ frequency gain 6dB

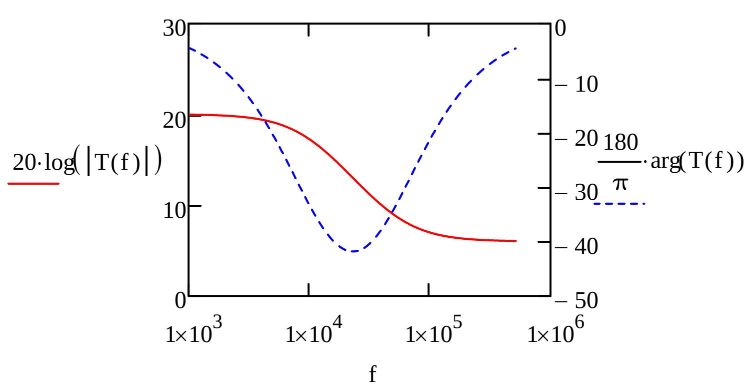
Solution Pick $C := 0.015\mu F$

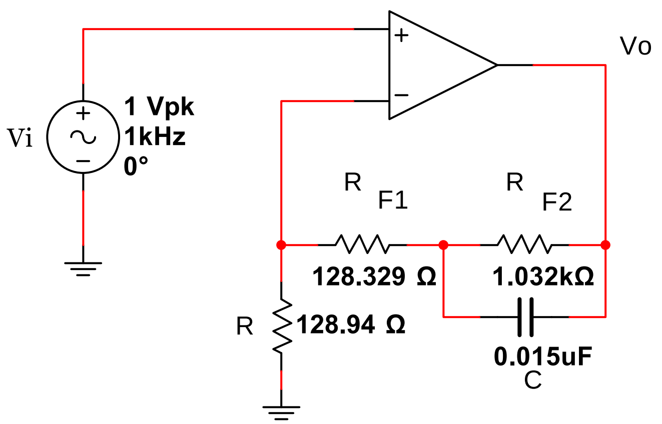
$$\tau_p := \frac{1}{2\cdot\pi\cdot f_p} \qquad R_{F2} := \frac{\tau_p}{C} = 1.032\,k\Omega \qquad K := 10^{\frac{20}{20}} = 10 \qquad K_H := 10^{\frac{6}{20}} = 1.995$$

$$R := \frac{R_{F2}}{K-K_H} = 128.94\,\Omega \qquad R_{F1} := R\cdot\left(K_H - 1\right) = 128.329\,\Omega \qquad \tau_z := \frac{K_H}{K}\cdot\tau_p \qquad f_z := \frac{1}{2\cdot\pi\cdot\tau_z}$$

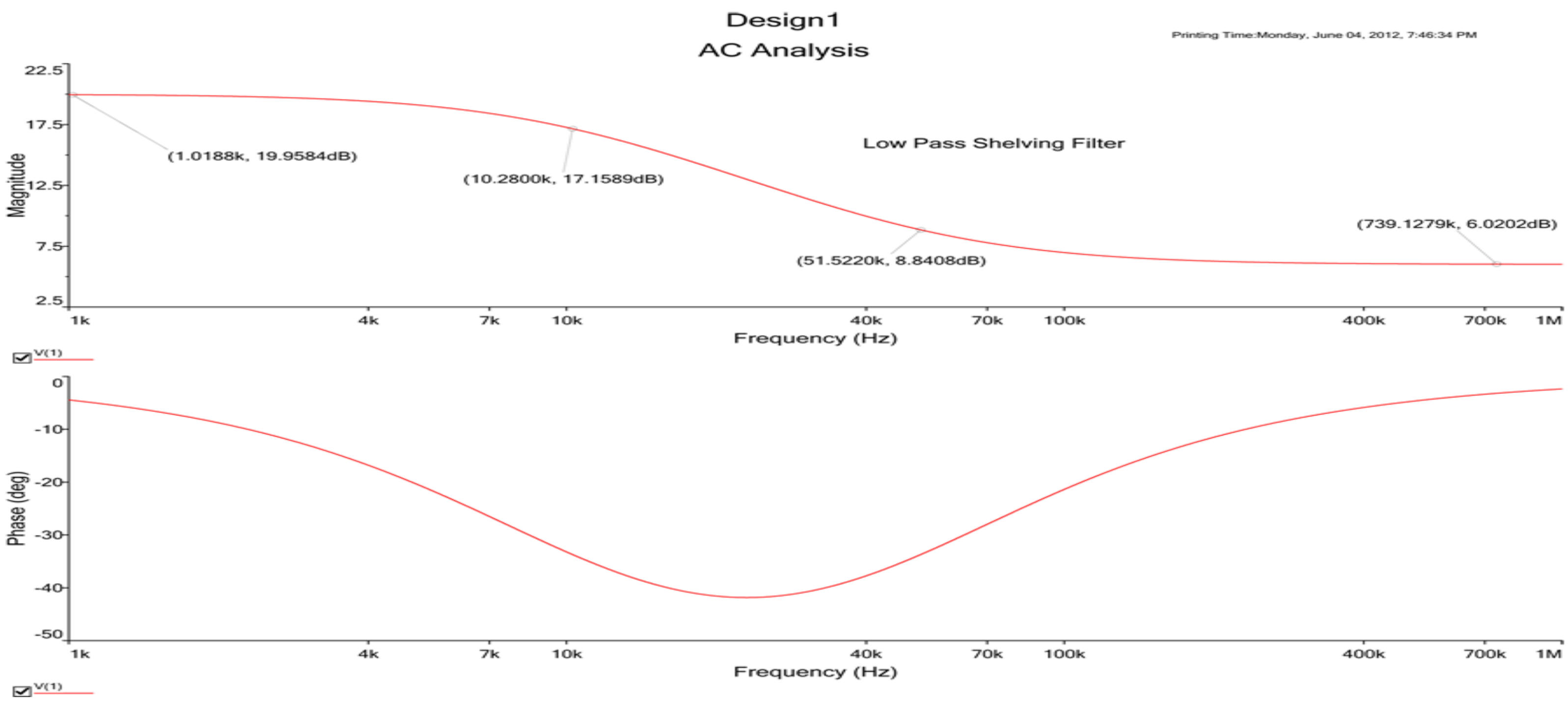
$$f_z = 51.522\,kHz$$

$$T(f) := K\cdot\frac{1 + j\cdot\frac{f}{f_z}}{1 + j\cdot\frac{f}{f_p}}$$



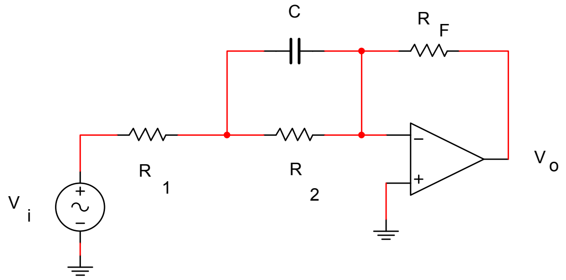


Low Pass Shelving Filter



High Pass Shelfving Filter $\quad j := \sqrt{-1} \quad f_{crit} := 10.28\,kHz$

$$T(s) = K\cdot\frac{1 + s\tau_z}{1 + s\tau_p}$$



$$T(0) = K = \frac{-R_F}{R_1 + R_2}$$

$$T(\infty) = \frac{-R_F}{R_1} \qquad \tau_z = R_2\cdot C$$

$$\tau_p = \left(R_2 \| R_1\right)\cdot C$$

$$f_p = \frac{1}{2\pi\cdot\tau_p} \qquad f_z = \frac{1}{2\pi\,\tau_z}$$

Specification $\quad f_z := f_{crit}$ $\quad$ DC gain $\quad$ 6dB

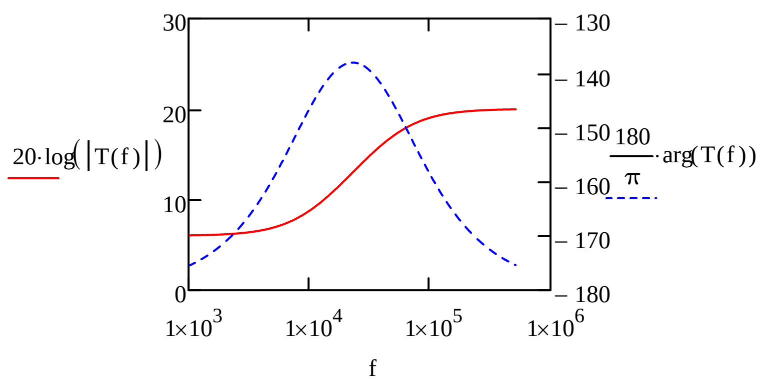
∞ frequency gain $\quad$ 20dB

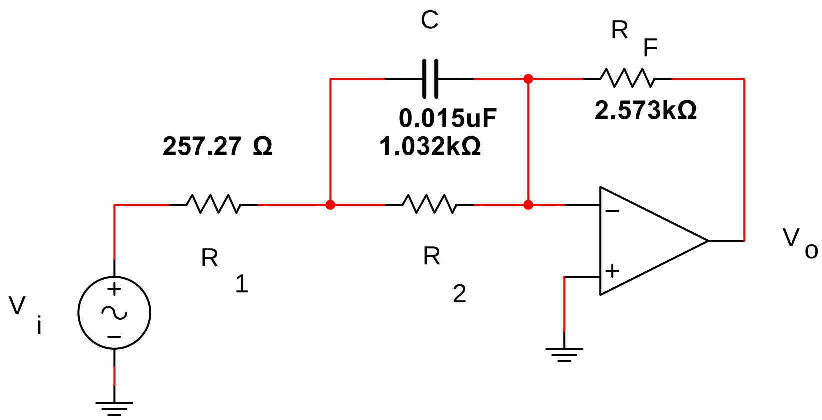
Solution $\quad$ Pick $\quad C := 0.015\,\mu F$

$$\tau_z := \frac{1}{2\cdot\pi\cdot f_z} \qquad R_2 := \frac{\tau_z}{C} = 1.032\,k\Omega \qquad K := -(10)^{\frac{6}{20}} = -1.995 \qquad K_H := -10^{\frac{20}{20}} = -10$$

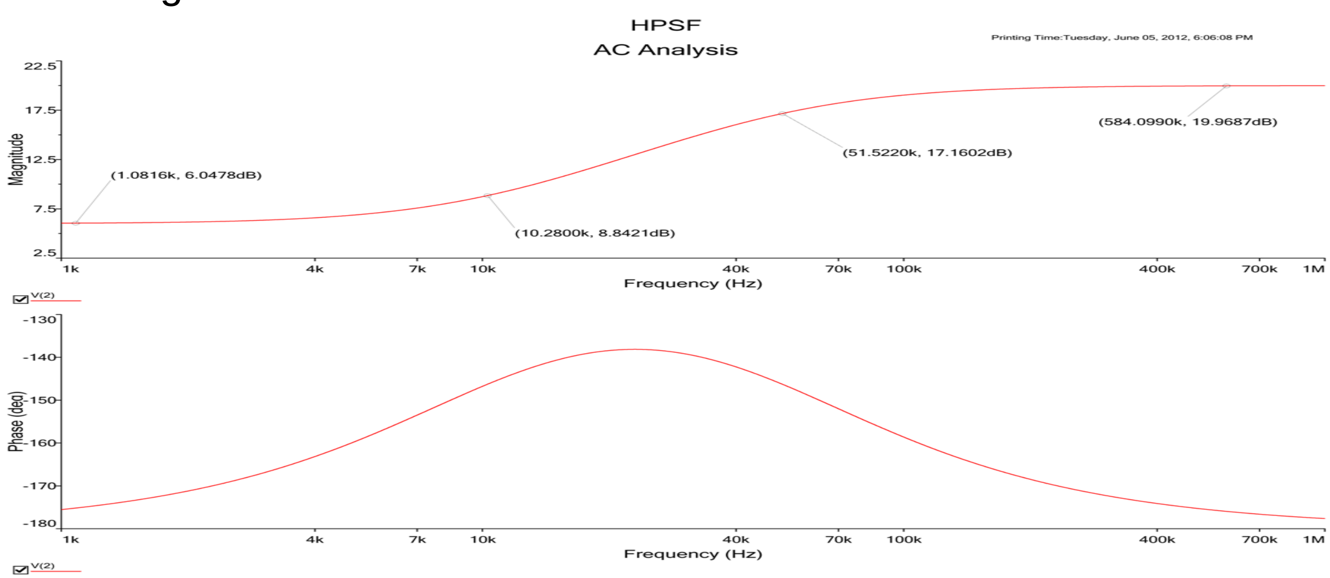
$$R_F := \frac{R_2}{\frac{1}{K_H} - \frac{1}{K}} = 2.573\,k\Omega \qquad R_1 := \frac{-R_F}{K_H} = 257.27\,\Omega \qquad \tau_p := \frac{K}{K_H}\cdot\tau_z \qquad f_p := \frac{1}{2\cdot\pi\cdot\tau_p}$$

$$T(f) := K\cdot\frac{1 + j\cdot\frac{f}{f_z}}{1 + j\cdot\frac{f}{f_p}} \qquad f_p = 51.522\,kHz$$

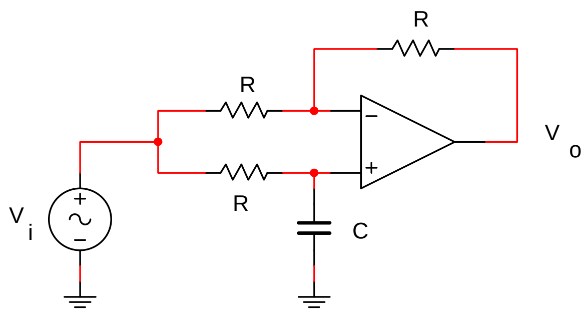




High Pass Shelving Filter



First Order All Pass Filter Inverting Phase $j := \sqrt{-1}$



$T(s) = K \cdot \frac{1 - s\tau}{1 + s\tau}$

$K = 1$ $\tau = RC$

Frequency at which phase shift is - 90 degrees

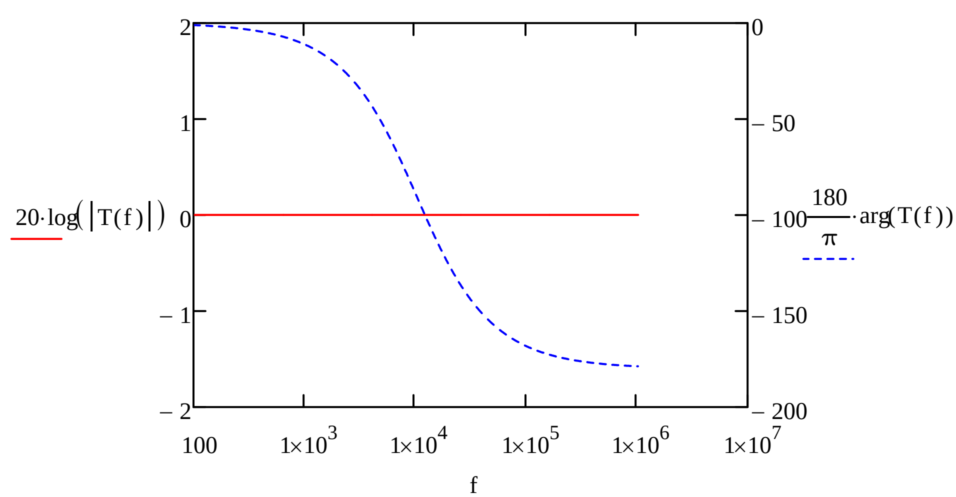
$f_o = \frac{1}{2\pi\tau}$

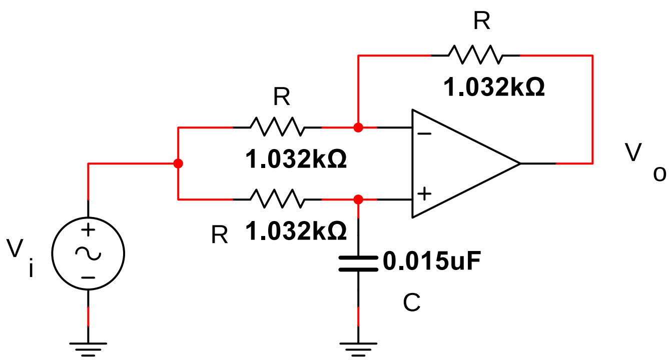
Specification

$f_{crit} := 10.28 kHz$ $f_o := f_{crit}$ Pick $C := 0.015 \mu F$ $K := 1$

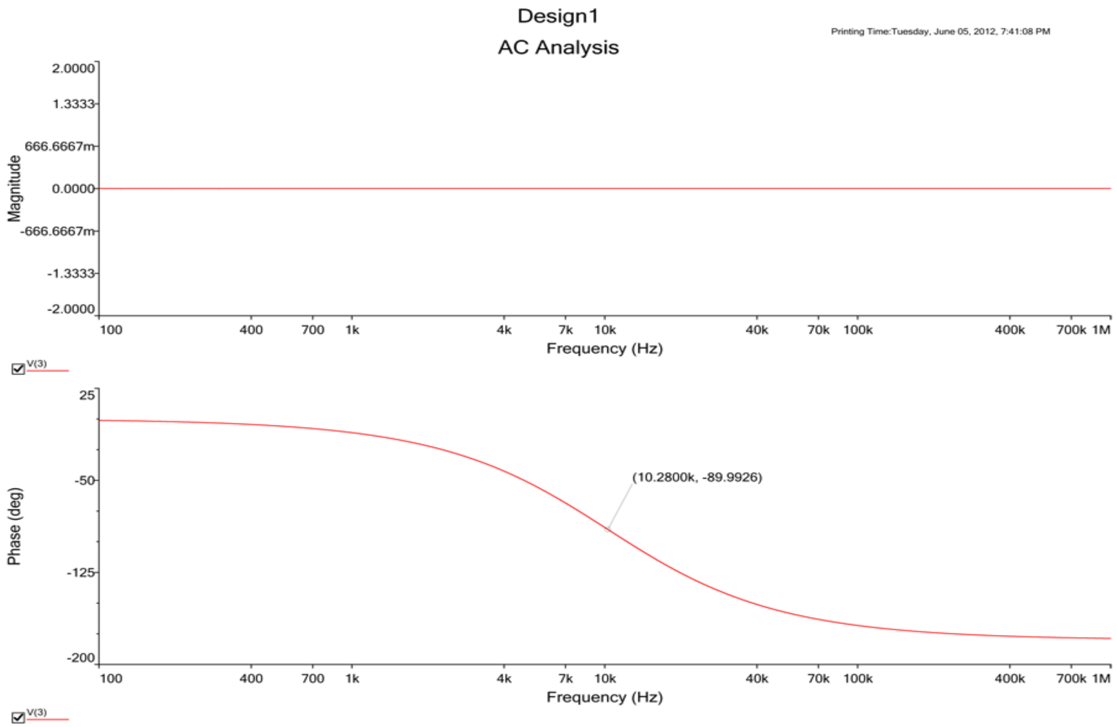
$R := \frac{1}{2 \cdot \pi \cdot C \cdot f_o} = 1.032 \cdot k\Omega$

$$T(f) := K \cdot \frac{1 - j \cdot \frac{f}{f_o}}{1 + j \cdot \frac{f}{f_o}}$$





First Order Inverting All Pass Filter



Georgia Institute of Technology

School of Electrical and Computer Engineering

ECE 3043 Electrical and Electronic Circuits Laboratory Verification Sheet

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NAME:_______________________________________ SECTION:__________________________

AD LOGIN:_________________________________

Experiment 7: First Order Active Filters

Procedure	Time Completed	Date Completed	Verification (Must demonstrate circuit)	Points Possible	Points Received
1. Low Pass				20	
2. High Pass				20	
3. High Pass Shelving				20	
4. Low Pass Shelving				20	
5. All-Pass				20	

If you were born on or before June 30, your critical frequency is found from your birthday as Month.Day kHz. If you were born after June 30, your critical frequency is (Month.Day/2) kHz. Ex 1: If you were born on March 3, your critical frequency is 3.03 kHz. Ex 2: If you were born on December 18, your critical frequency is 6.09 kHz.

Enter your critical frequency below:

f_{crit}	

To be permitted to complete the experiment during the open lab hours, you must complete at least **three** procedures during your scheduled lab period or spend your entire scheduled lab session attempting to do so. A signature below by your lab instructor, Dr. Brewer, or Dr. Robinson permits you to attend the open lab hours to complete the experiment and receive full credit on the report. Without this signature, you may use the open lab to perform the experiment at a 50% penalty.

SIGNATURE:__________________________________ DATE:__________________________________

ECE 3043 Check-off Requirements for Experiment 7

Make sure you have made all required measurements before requesting a check-off. For all check-offs, you must demonstrate the circuit or measurement to a lab instructor. All screen captures must have a time/date stamp.

1 & 2. Low Pass and High Pass Filters

- ✓ Bode magnitude plot
- ✓ Table showing measured pass band gain and -3dB frequencies compared to design values

3 & 4. Low and High Pass Shelving Filters

- ✓ Bode magnitude plot
- ✓ Table showing measured low frequency gain, high frequency gain, and gain at f_{crit} compared to design values

5. All Pass Filter

- ✓ Bode Phase Plot
- ✓ Measure frequency where phase shift is 90 degrees. Compare to f_{crit}.